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(56) Documents Cited
GB 2302219 A GB 1112473 A GB 0737058 A
EP 0386918 A2 WO 94/03027 A1

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ONLINE:WP1,CLAIMS,JAPIO

(54) Abstract Title
Terminal arrangement for a thick film heater

(57) A thick film heater 2 comprises a thick film heating track 8 provided on an electrically insulating substrate 6. An electrical contact member 16 of silver or similar is bonded to a contact receiving pad 1 of the heater track 8 by being deposited on the unfired pad and then being co-fired with the pad.

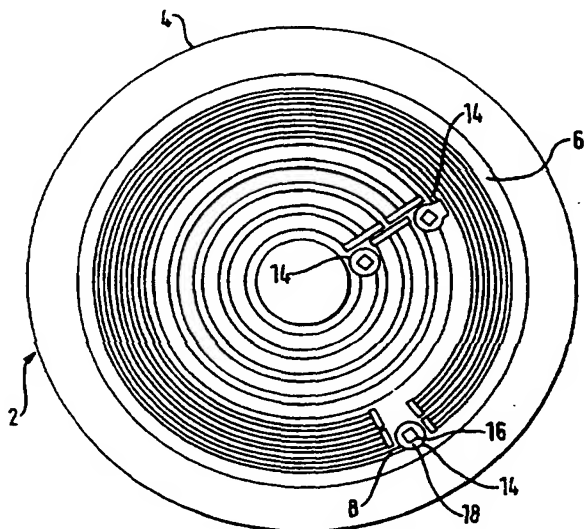


FIG. 1

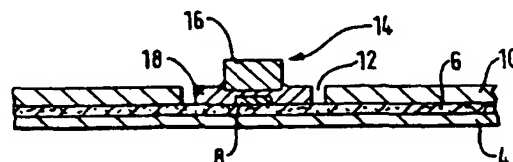


FIG. 2

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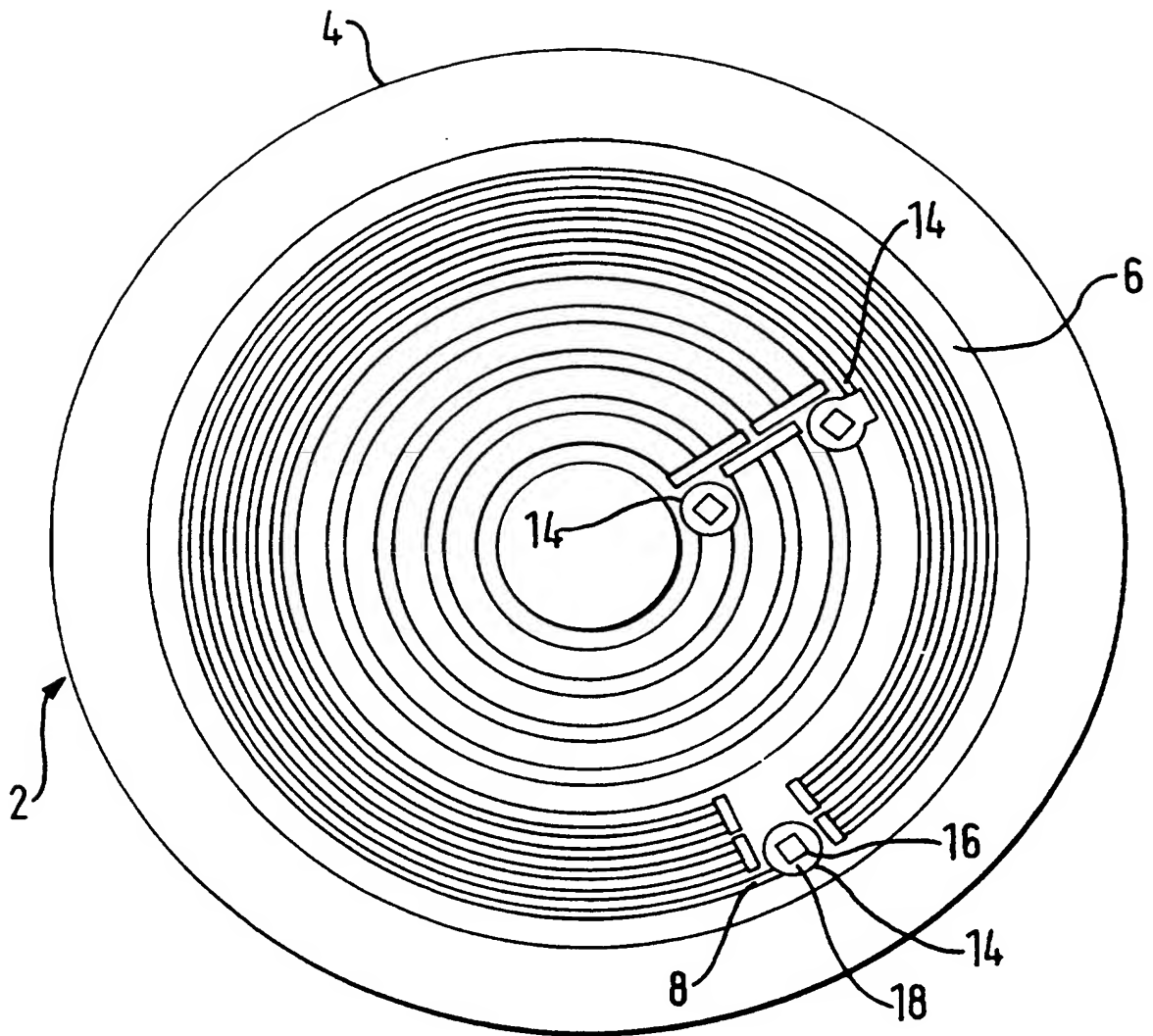


FIG. 1

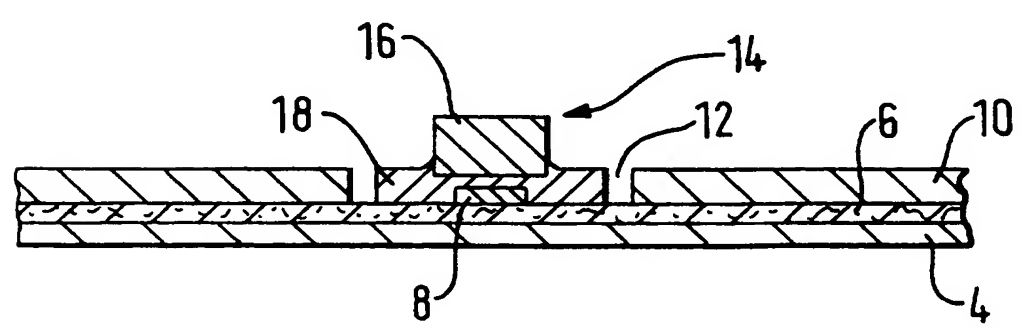


FIG. 2

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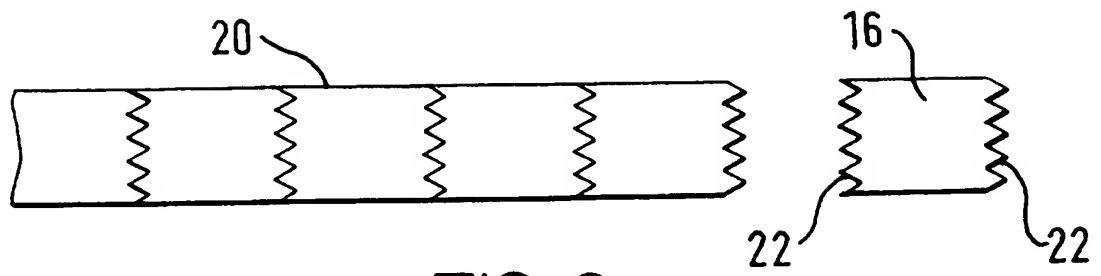


FIG. 3

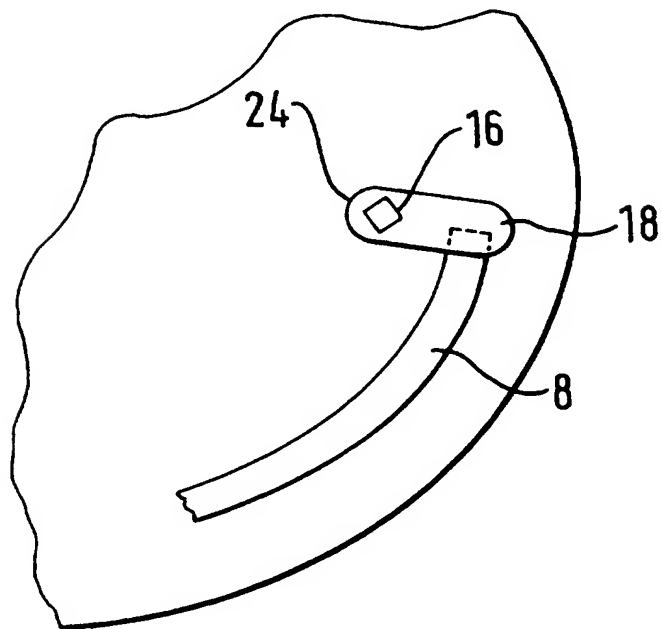


FIG. 4

Thick Film Heaters

5 The present invention relates to thick film heaters which can be used particularly, but not exclusively, in liquid heating apparatus such as kettles, hot water jugs and so on.

10 A thick film heater comprises a so-called 'thick film' resistive heating track printed and fired onto an electrically insulating substrate. Typically during manufacture one or more layers of an insulating glass ceramic ink are deposited onto a metallic support and fired to form an insulating layer on the support. An
15 electrically resistive ink is then printed onto the insulating layer in a desired track pattern and fired to produce the heating track. The track may then be over-printed with a protective glass ceramic glaze which is also fired.

20 The heating track is also provided with terminals through which electrical connection to the track is made. This connection can be made in a number of ways. For example in one proposal a connecting electrical lead is soldered onto the track and using an appropriate
25 solder. However such a connection is vulnerable to being pulled off. More commonly, however, the track is provided with printed silver contact pads. Normally these pads are formed by printing over the end portions of the track with a suitable ink which is then fired. A
30 connection is made to the track, for example with a formed leaf spring, as shown in GB 2283156, or by a sprung knife edge contact. The problem with such a contact is, however, that contact is only made along a line which means that overheating of the contact may
35 well occur. As the pad is very thin (typically 10-15 μm) it will not last very long.

 Furthermore where the contact on the track is used

as a fixed contact of a contact pair, with a movable contact of the pair being provided in a control for the heater (as is proposed in our co-pending application filed on the same day entitled "Electric Heaters") these
5 contacts will not suffice as they cannot resist the wear or arcing which will occur when the contacts open and close. In such applications, therefore, a more substantial contact is needed which will be able to withstand wear and/or arcing which would normally occur
10 with a control housing away from the track.

From a first aspect, therefore, the invention provides a thick film heater comprising a thick film heating track provided on an electrically insulating substrate, and having an electrical contact member
15 bonded to the heater.

The invention also extends to a method of making a thick film heater comprising a thick film heating track provided on an electrically insulating substrate wherein a contact member is bonded to the heater.

20 Thus in accordance with the invention, a separate contact member is bonded to the heater to provide a contact which may better withstand wear and high temperatures particularly where the contact is one of a set of switch contacts. Furthermore, it will enable a
25 more acceptable electrical contact to be made even with a non-movable connection such as a leaf spring. The bonded contact will also provide a larger interface area with an underlying track, reducing heating at the interface, thereby prolonging contact life.

30 The contact member may be bonded to the heater using an electrically conductive bonding material, for example a solder or braze material, which will be capable of withstanding the anticipated operating temperatures of the heater. This could be done during a
35 firing operation during manufacture of the heater. However, it has been found that an extremely strong bond can be achieved if the contact member is merely

positioned on an area of unfired material on the heater and then fired with it to bond the contact member to the resultant fired material.

5 The contact member may be positioned onto an unfired section of the track itself but more preferably it is positioned onto a contact receiving pad of high conductivity material, such as that presently used to produce contact pads, which is in electrical connection with the track.

10 It is not essential that the contact member is positioned on the contact receiving pad such that it overlies a portion of the track. For example, the contact receiving pad may be elongate, and the contact member positioned at an end thereof remote from the
15 track.

 Accordingly in very broad terms the present invention also provides a method of mounting a contact member on a thick film heater wherein the contact member is positioned in a desired position on an area of
20 unfired material and the unfired material and contact member are fired together to secure the contact member in position.

 The various unfired materials referred to above will normally be layers of ink printed onto the heater in an appropriate pattern. To improve the adhesion of
25 the contact member, the unfired material ink may be printed thicker under the contact member, or additional ink deposited in an appropriate manner prior to positioning the contact member.

30 Furthermore, in order to improve its adhesion, the contact member is preferably deposited onto an ink layer whilst the ink is still wet. It may be pressed into the ink and possibly also be vibrated at the same time. Positioning the contact member on wet ink not only acts
35 to wet the bottom of the contact member, thereby improving adhesion, but also acts to some extent positively to locate the contact member on the heater,

which is beneficial during subsequent processing where the contact member may be subject to external forces, eg. vibration, as it passes through a firing furnace.

5 The firing of the contact member onto the heater may be conducted as a separate operation, but most preferably it is carried out at the same time as another firing operation in the heater manufacture. For example, the heater track, the contact receiving pad, and possibly an overglaze layer may all be printed on a
10 fired, or unfired insulating substrate. After all the printing operations have been completed, the contact member is positioned on the intermediate contact layer, and the whole assembly then fired.

The contact member may be made of conventional
15 contact materials. Where, as is preferred, the contact member is intended to form one of a set of switch contacts, the contact forming face of the contact may advantageously be made from Ag/CdO, Ag/No or more preferably pure silver which gives very low contact
20 interface resistance. This minimises heating in the contact region, which keeps the temperature of the track and insulating materials below the contact to a minimum.

The contact member may also be formed as a composite contact having a facing as discussed above
25 with a suitable backing material. Preferably the backing material is a ferrous alloy, for example comprising Nickel and/or Chromium, rather than the more common Cu/No backing material. Ferrous alloys are preferred as they exhibit improved oxidation resistance
30 during firing.

The contact member may be cut from a wire or tape of contact material. Further the heater-facing side of the contact may be roughened, for example by forming annular or cross hatch patterns, to as to improve the
35 adherence of the contact member. Alternatively or in addition, the edges of the contact member may be roughened, for example with serrations to improve keying

into the underlying material.

A preferred embodiment will now be described by way of example only, with reference to the accompanying drawings in which:

5 Figure 1 shows a first embodiment of the invention;
 Figure 2 shows, schematically, a section along line II-II of Fig. 1;

 Figure 3 shows schematically production of contact members; and

10 Figure 4 shows a further embodiment of the invention.

 Referring firstly to Figure 1, a thick film heater 2 comprises a 0.5 mm thick stainless steel plate 4 upon which is provided an 100 μ m thick layer 6 of insulating
15 material. On top of the insulating layer 6 is a tortuous thick film heating track 8, about 15 μ m thick.

 A protective overglaze 10 about 15 μ m thick (Figure 2) is provided over substantially the whole surface of plate 4. However, apertures 12 are provided around
20 three contact locations 14 on the tracks, so that electrical connections can be made to the track 8 at those locations.

 At each contact location 14, a silver contact member 16 about 0.5 mm thick is bonded to the track 8
25 via a silver contact receiving pad 18.

 Each contact member 16 is generally square in section, being cut e.g. stamped, from the end of a tape 20, as shown in Figure 3. The cut is a serrated one, whereby opposed serrated edges 22 are provided on the
30 contact member 16. This will improve its bonding to the track in that during firing, as will be described below, material will be drawn up into the serrations.

 A particular method of manufacturing the heater 2 described above will now be described.

35 Firstly, a layer 6 of insulating ink such as Dupont 3500 is printed onto the plate 4, in a single or multiple operation, to a depth of about 150-200 μ m.

This layer 6 may then be fired at about 850°C for about 30 minutes to produce the finished insulating layer 6.

After firing, the resistive heating track 8 of a material such as a mixture of Dupont 3542 and 3544 is
5 printed to a thickness of about 15-20 μm . Then contact receiving pads 18 of Dupont 7760 are printed in the appropriate positions to a thickness of about 15-20 μm , and finally an overglaze 10 of Dupont 3500 printed to a thickness of about 15-20 μm over the whole of the
10 insulating layer 6, apart from the areas around the contact locations 14.

Then while the contact receiving pads 18 are still wet the contact members 16 are positioned on the pads 18. The contact members 16 are pressed into the pads 18
15 to ensure good contact, and may even be vibrated into a position to eliminate gas bubbles etc. under the contact member 16.

Once the contact members 16 are positioned, the heater 2 may then be fired at about 850°C for about 30
20 minutes both to fire the track 8, contact receiving pads 18 and overglaze 10 and to bond the contact members 16 in position. During the firing operation, the contact receiving pads 18 will initially soften and, if they have not done so already, fill interstices in the lower
25 surface of the contact members by capillarity. The material will also be drawn up around the edges of the contact member 16 into the serrations therein. After further time, the pad material will harden to firmly secure the contact members in position.

30 It has been found, perhaps surprisingly, that the firing process does not oxidise the contact member 16.

Various modifications to the above embodiment may be made without departing from the scope of the invention. For example, all the layers including the
35 insulating layer 6 may be fired at once. Also, as shown in Fig. 4, the contact member 16 need not directly overlie the track 8. In this embodiment, the silver

contact pad 18 is extended away from the end of the track 8 and the contact member 16 mounted at the end 24 of the pad remote from the track end. The elongated contact pad 18 acts to secure the contact member 16 and connect it electrically to the track 8.

Further, the contact member 16 need not be square and can take whatever shape is desired, for example, circular, but a square or rectangular contact member offers advantages in manufacture, as discussed above.

Claims:

1. A thick film heater comprising a thick film heating track provided on an electrically insulating substrate, and having an electrical contact member bonded to the heater.
2. A method of making a thick film heater comprising a thick film heating track provided on an electrically insulating substrate, wherein a contact member is bonded to the heater.
3. A method as claimed in claim 2 wherein the contact member is positioned on an area of unfired material on the heater and then fired to bond the contact member into position.
4. A method as claimed in claim 3 wherein the contact member is positioned on an unfired area of the track.
5. A method as claimed in claim 3 wherein the contact member is positioned on an unfired contact receiving pad.
6. A method as claimed in any of claims 3 to 5 wherein said contact member is pressed into said unfired material.
7. A method as claimed in any of claims 3 to 6 wherein said contact member is vibrated during positioning.
8. A method as claimed in any of claims 3 to 7 wherein said unfired material is deposited in the form of an ink, and the contact member is deposited thereon whilst the ink is still wet.

9. A method as claimed in any of claims 2 to 7 wherein an overglaze is deposited over the track prior to positioning the contact member.

5 10. A method of manufacturing a thick film heater comprising: depositing an insulating layer on a metal substrate and firing the insulating layer, depositing a thick film track onto the insulating layer; depositing a contact receiving pad at least partially overlapping
10 said track; positioning a contact member on said contact receiving pad; and firing together said track, contact receiving pad and contact member.

11. A heater or method as claimed in any preceding
15 claim wherein the contact member comprises silver.

12. A heater or method as claimed in claim 11 wherein the contact member is cut from a silver wire or tape.

20 13. A heater or method as claimed in any preceding claim wherein the heater-facing side and/or the edges of the contact member is/are roughened.



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Application No: GB 9703224.7
Claims searched: 1-13

Examiner: John Cockitt
Date of search: 25 April 1997

Patents Act 1977 Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.O): H5H (HAFX, HAF2, HAF3, HAF7, HAX2)

Int Cl (Ed.6): H05B [03/06, 03/26, 03/74, 03/82, 03/84, 03/86]; H01R [43/02, 04/02]

Other: ONLINE: WPI, JAPIO, CLAIMS

Documents considered to be relevant:

| Category | Identity of document and relevant passage | Relevant to claims |
|----------|--|----------------------|
| X | GB2302219A PHET - see p5 lns18-21 | 11 |
| X | GB1112473A FUJI - see whole document | 1-6,10 at least |
| X | GB0737058A WURTTENBERGISCHE - see whole document | 1-3,13 at least |
| X | EP0386918A2 THORN - see whole document | 1-6,9,10-13 at least |
| X | WO94/03027A1 RESEARCH - see fig | 1,2 at least |

X Document indicating lack of novelty or inventive step
Y Document indicating lack of inventive step if combined with one or more other documents of same category.
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P Document published on or after the declared priority date but before the filing date of this invention.
E Patent document published on or after, but with priority date earlier than, the filing date of this application.



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Application No: GB 0217351.6
Claims searched: 1 - 28

Examiner: Bill Riggs
Date of search: 17 January 2003

Patents Act 1977 : Search Report under Section 17

Documents considered to be relevant:

| Category | Relevant to claims | Identity of document and passage or figure of particular relevance |
|----------|--------------------|--|
| A | | GB 2322272 A (Strix Ltd.) see whole document |
| A | | GB 2193617 A (AKO Werke) see whole document |

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H05B 3/68

The following online and other databases have been used in the preparation of this search report:

Online databases: EPODOC, JAPIO, WPI